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poses of final identification. As far as possible only those chemical reactions are described that are necessary to identify the minerals, and these are always simple ones.

The book is too well known to all mineralogists to require further characterization. It is sufficient praise to state that the fourth edition is an advance over all the editions that have preceded it.

W. S. B.

Hardness of Minerals. — Jaggar has described[1] a new instrument for the determination of the hardness of minerals. After briefly summarizing the results of previous workers on this subject, he describes the chief sources of error in their methods as follows: "(1) personal variability due to using 'visibility' of a scratch as determinant; (2) inequalities of surface; (3) undefined details of instrument. To eliminate (1) the depth of abrasion should be definite and measurable; to eliminate (2) the surface should be artificial and defined, and the boring method, where only a very small portion of the surface is initially touched, should be used; to eliminate (3) every part of the instrument, including the abrader, should be minutely defined, and for comparative determination an empirical standard should be fixed."

The instrument devised to overcome these difficulties and to meet the other conditions of the problem presented is intended to be applied to the microscope in order that the measurements may be made either on a crystal face or the surface of a thin section, that the test may be applied to very small portions of mineral, and that the control of the instrument may be very exact. "The principle of the instrument is as follows: a diamond point of known, constant dimensions is rotated on an oriented mineral surface, under uniform rate of rotation and uniform weight, to a uniform depth. The number of rotations of the point, a measure of the duration of the abrasion, varies as the resistance of the mineral to abrasion by diamond; this is the property measured. The instrument consists of the following parts:

(1) A standard and apparatus for adjusting to microscope with various adjustments.

(2) A balance beam and its yoke.

(3) A rotary diamond in the end of the beam.

(4) Apparatus for rotating uniformly.

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[1] Jaggar, T. A., Jr. A Microsclerometer for Determining the Hardness of Minerals. *Am. Jour. of Sci.*, vol. iv, pp. 400–412, 1897.

Also *Zeit. f. Krystall.*, vol. xxix, pp. 262–275, 1898.

(5) Apparatus for recording rotations.
(6) Apparatus for locking and releasing beam.
(7) Apparatus for recording depth.

After giving detailed descriptions of the various parts of the instrument and the method of use and calibration, the results are given of a preliminary series of tests on the minerals of the Mohs scale of hardness, and the following table shows the values obtained, together with those of two other investigators for comparison:

	Pfaff, 1884.	Rosiwal, 1892.	Jaggar, 1897.
9. Corundum	1000	1000	1000
8. Topaz	459	138	152
7. Quartz	254	149	40
6. Orthoclase	191	28.7	25
5. Apatite	53·5	6.20	1.23
4. Fluorite	37·3	4·70	·75
3. Calcite	15·3	2.68	.26
2. Gypsum	12.03	·34	·04

The possibility is suggested of using the instrument for other ends than the determination of hardness; the extreme exactness of the appliance for measuring the vertical movement of the diamond point makes it possible to determine the thickness of a mineral section, and of the thickness of a mineral necessary to produce in polarized light a given interference color, whence the double refraction may be calculated. The borings from very minute crystals in thin section might also be subjected to chemical tests, — a novel method of isolation.

Tables of Crystal Angles. — Goldschmidt, continuing his valuable work on the use of the goniometer with two circles, has published a table[1] of angles for the forms of all crystallized minerals. The construction of such a table is first made possible by the new method of measurement of crystals involved in this goniometer. In the old method of measurement of interfacial angles, such a table involved the presentation of the angles which each form makes with every other, and the number of values would be so great that its very bulk would render it impracticable or even useless. Monographs on individual mineral species contain approximations to such complete tables of angles, but these were widely scattered through the literature. But with the two-circle goniometer, each face is determined independently, once the crystal is oriented on the instrument, by the measurement of two angles which suffice, the crystallographic ele-

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[1] Goldschmidt, V. *Krystallographische Winkeltabellen.* Berlin, J. Springer, 1897.